Sampling and Analysis Plan for Radiological Characterization of Selected Materials and Areas at the Newfield Facility

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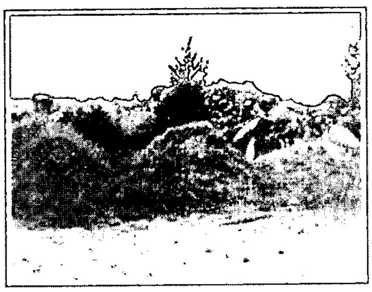

Shieldalloy Metallurgical Corporation

Report No. 94005/G-29353 (Rev. 0)

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1 INTRODUCTION

Shieldalloy Metallurgical Corporation (SMC) operated a manufacturing facility in Newfield, New Jersey. This facility manufactured speciality steel and super alloy additives primarily aluminum master alloys, metal carbides, powdered metals, and optical surfacing products. Raw material used at the facility included ores which contain oxides of columbium (niobium) vanadium, aluminum metal, titanium metal, strontium metal, zirconium metal, and fluoride (titanium and boron) salts. During the manufacturing process, slag, dross, and baghouse dust were generated.

One of the materials that was received, used and stored by SMC contained radioactive material which is classified as "source material" pursuant to Title 10, Code of Federal Regulations, Part 40. This material, pyrochlore, is a concentrated ore containing columbium (niobium). Pyrochlore contains greater than 0.05% of natural uranium and natural thorium and its possession/use is thus licensed by the U.S. Nuclear Regulatory Commission (USNRC).

SMC currently holds USNRC License No. SMB-743 which, at one time, allowed the possession, use, storage, transfer and disposal of source material at its Newfield, New Jersey site. Figure 7.1 is an aerial photograph of the site. At this time, the license authorizes storage pending decommissioning only, upon approval of a decommissioning plan (DP) which has been prepared and submitted to the USNRC.[1]

Recently the USNRC requested additional information in order to complete its safety review of the DP.[2] The following requests for additional information (RAI) are those that triggered the need for additional sampling and measurements at the site:

- RAI 7, *Provide basis for the radionuclide concentrations for material to be consolidated into the restricted area cell.* This RAI identified that there is a lack of supporting radionuclide concentration data used for the derived source term of some of the materials proposed for consolidation in the restricted area cell.

- RAI 9, *Provide a complete discussion about radiological contamination in the Hudson Branch.* This RAI identified that the information regarding contamination in the Hudson Branch is dated.

[1] "Decommissioning Plan for the Newfield Facility", Report No. 94005/G-28247, (Rev 1a), Submitted by Shieldalloy Metallurgical Corporation, Newfield, New Jersey, June 30, 2006.

[2] Letter To Mr. David R. Smith, Shieldalloy Metallurgical Corporation, From Keith I. McConnell, Deputy Director Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, USNRC, Subject: Request for Additional Information for Safety Review of Proposed Decommissioning Plan for Shieldalloy Metallurgical Corporation, Newfield, New Jersey, July 5, 2007

- RAI 10, *Describe the remedial characterization data that will be needed to evaluate residual radioactivity in soils that have not been identified or sufficiently characterized.*

The USNRC, in RAI No. 7 in particular, asks for not only a more detailed discussion of how the Storage Yard source term was developed, but for supporting measurement data as well. It is assumed that based on process knowledge and existing sampling data, there is sufficient information to characterize the slag and baghouse dust. Rev. 1a of the DP assumed the radionuclide concentration of the soil and building rubble in the Storage Yard was low with respect to the concentration in the slag, thus nominal assumptions about actual levels only, not sampling results, were used for the dose modeling. Excavated soil from the remediation of the eastern portion of the Storage Yard and soil/demolition rubble from the decommissioning of former process buildings that will be consolidated into the restricted area cell requires additional sampling to characterize the radionuclide concentration of these materials.

An assessment of radiological conditions in/near the Hudson Branch watershed was performed by ENSR in 1991 that included both radiation surveys and sample collection/analysis[3]. While the data set from that assessment permits characterization of the radioactivity therein, the USNRC has asked SMC to confirm whether radiological conditions remain the same today as part of its inquiry into planned remediation of the area (see RAI No. 9). Therefore, additional measurements and sampling, sufficient to validate the 1991 data set, are also required.

This sampling, measurement and analysis plan, hereinafter referred to as the SAP, has been prepared to address collection and analysis of samples from selected portions of the site, for the following purposes:

- To characterize radiological concentrations in selected Storage Yard stockpiles for the purposes of comparison to assumptions made in the DP;
- To reevaluate (and compare to previous studies) radionuclide concentrations and exposure rates in the Hudson Branch watershed; and
- To investigate the radiological status of an area along the southwest fence line that had been previously been identified as creating elevated exposure rates, but not confirmed to be associated with licensable material.[4]

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[3] ENSR Document Number 5990-006-410, Radiological Characterization of the Shieldalloy Metallurgical Corporation Newfield, New Jersey Facility, December 1991.

[4] ENSR Document Number 5990-006-410, Radiological Characterization of the Shieldalloy Metallurgical Corporation Newfield, New Jersey Facility, December 1991.

Included herein is a brief history and description of the site, a statement of the objectives of the sampling and analysis campaign, a description of the field activities to be performed, the quality assurance goals associated with the sampling, measurement and analysis effort, and a description of the recordkeeping and reporting program.

1.1 Site Description and History

The facility is located at 35 South West Boulevard in Newfield, New Jersey. During the ferrocolumbium manufacturing process, the facility generated slag, dross, and baghouse dust. The primary portion of the site, consisting of the manufacturing facilities and their support areas, covers 67.7 acres. An additional 19.8 acres of farmland, located approximately 2,000 feet southwest of the primary site in Vineland, Cumberland County, New Jersey, are also owned by SMC. The area to the west/northwest of the site industrial in nature, wooded to the east, open/wooded/residential to the south, and agricultural/landfill to the north/northeast.

Metal and metal alloy manufacturing operations at the Newfield site began in the late 1950's. An Atomic Energy Commission license for use of ores that contained source material was issued in 1963 and later re-issued by the USNRC as License No. SMB-743, which authorizes possession of up to 303,050 kilograms of thorium and 45,000 kilograms of uranium. In late 2002, operations involving source material ceased. As of October 21, 2005, the SMC inventory of licensed materials was at 96.8% of the thorium limit and 87.6% of the uranium limit.[5]

The DP submitted to the USNRC proposes to consolidate all licensable residual radioactive materials at the Newfield site within a portion of the existing Storage Yard, located on the eastern boundary of the plant. There it will be graded, covered with an engineered barrier and subject to long-term maintenance and monitoring.

1.2 Project Organization

The SAP activities will be implemented, on behalf of SMC, by Integrated Environmental Management, Inc. (IEM). On site will be an National Registry of Radiation Protection Technologists (NRRPT) Registered Project Manager, who will be assisted by field technicians with the necessary qualifications and experience to perform the required tasks. IEM is licensed by the Maryland Department of the Environment (MDE License No. MD-31-281-01), a USNRC Agreement State, to perform the types of radiation-related services required for this project. However, the work itself will be performed under the terms/conditions of License No. SMB-743, issued to SMC.

[5] Decommissioning Plan for the Newfield Facility, Report No. 94005/G-28247, (Rev 1a), Submitted by Shieldalloy Metallurgical Corporation, Newfield, New Jersey, June 30, 2006.

1.3 Previous Investigations

1.3.1 Storage Yard

The following is a listing of previous investigations into the radiological characteristics of the various stockpiles within the Storage Yard:

- Oak Ridge Associated Universities (ORAU) performed a study of the SMC Newfield site in 1987. This study included samples of soil, water sediments, slag and baghouse dust as reported in *Radiological Survey of the Shieldalloy Corporation Newfield, New Jersey*, J.D. Berger and A.D. Luck, ORAU 88/G-79, July 1988. Thirty (30) slag samples and four (4) baghouse dust (BHD)samples were analyzed by ORAU during this effort.

- SMC obtained seven (7) slag samples in July and August 1994. These samples were analyzed by EcoTec laboratory and the results reported in an October 3, 1994 Letter from Carol D. Berger to C. Scott Eves, SMC, Re: SLAG Sampling Program Summary.

- SMC obtained two (2) samples of slag in November 1994. These samples were analyzed by EcoTec laboratory and the results reported in a January 12, 1995 Letter from Carol D. Berger to C. Scott Eves, SMC, Re: CANAL Sampling Program Summary.

- IEM obtained fifteen (15) samples of baghouse dust in 1995. These samples were analyzed for thorium and uranium ppm at the University of Missouri. The results are reported in a September 11, 1995 letter from Carol D. Berger, IEM to C. Scott Eves, SMC, Re: Radiological Constituents in Samples Collected from the Lime Pile.

- Oak Ridge Institute for Science and Education (ORISE) Environmental Survey and Site Assessment Program (ESSAP) obtained four (4) samples of baghouse dust in 1997. These samples were analyzed by gamma spectroscopy and results for U-238, Ra-226, Th-232, Th-228, and reported in an October 14, 1997 letter from Dale Condra, Technical Resources Manager, ESSAP, to Marie Miller, U.S. NRC Region I, Subject: Report for Analysis of Dust Samples from Shieldalloy Metallurgical Corporation, Newfield, New Jersey (RFTA No. 97-24).

Appendix 8.1 summarizes the measurement results from the previous investigations into radiological constituents of the slag and baghouse dust. Table 6.1 provides a statistical summary of the radionuclide concentration data in Storage Yard materials (slag, baghouse dust, soil, and building debris) and the number of additional samples that will be collected during the implementation of this

SAP. Additional samples will not be collected for slag or baghouse dust since the radionuclide concentrations in these materials are assumed to be adequately represented by the existing data set.[6]

1.3.2 Hudson Branch and Southwest Fenceline

Pervious investigations into residual radioactivity along the Hudson Branch were documented in the 1991 ENSR study, *Radiological Characterization of the Shieldalloy Metallurgical Corporation Newfield, New Jersey Facility*, Document Number 5990-006-410, December 1991. This same study identified elevated exposure rates in a relatively confined area positioned along the southwest fence line of the plant.

1.4 Radionuclides of Concern

The radionuclides of concern at the Newfield facility are those associated with thorium and uranium source material. The uranium and thorium decay series are provided in Tables 6.2 and 6.3. The radionuclides in the Storage Yard materials are assumed to be in secular equilibrium with the parent radionuclides of the decay series (U-238 and Th-232). In the Hudson Branch, disequilibrium conditions exist due to the increased transportability of the radium isotopes in the environment, particularly in areas where there is water flow.

[6] Additional support for this assumption will be provided in SMC's response to the RAIs.

2 SCOPE AND OBJECTIVES

2.1 Scope of Work

The scope of work for this sampling campaign, as described previously, extends to three specific areas at the site. Specifically, it includes the following:

- Determination of the radionuclide concentration in the various soils and the concrete rubble from the demolition of Buildings D-111 and D102/112, all of which currently reside within the Storage Yard.
- Confirmation of the radionuclide concentration and area exposure rates in/near the Hudson Branch watershed as initially assessed by ENSR in 1991.
- Investigation by sampling and surveys of the area along the southwest fence line where elevated measurements were previously identified (ENSR 1991).

At pre-determined locations, samples will be collected, and sent to an offsite laboratory for radionuclide analysis. A commercial lab with a Quality Assurance (QA) plan and NELAC (National Environmental Accreditation Conference) accreditation in the State of New Jersey will be used. Sample analysis methods will be as described in Sections 3.4 and 4.3 of this SAP. All results will be validated, evaluated and reported as described in Section 5.4.

2.2 Data Quality Objectives

The Data Quality Objectives, or DQOs, for the Storage Yard sampling are as follows:

- Determine activity concentrations of excavated soil and building debris.
- Establish the mean concentration for use in dose modeling via systematic or random measurements.
- Collect a sufficient number of samples to allow for a statistical evaluation of the sampling results based on industry guidance.[7]
- Collect samples at a depth of 30 to 60 cm. (one to two feet) for soils, as opposed to surface sampling, in order to better represent activity concentrations within the soil stockpiles.

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[7] The number of samples to be collected is 17 for each material type using MARSSIM equation 5-2 and simplifying assumptions.

- The specific location and depth of demolition rubble samples will be wherever the field team determines a sample can be collected safely from a designated collection grid.
- Laboratory analysis will include a determination of the "percent moisture" of each sample, homogenizing the sample, drying the sample, and sealing the sample into counting containers to allow for the ingrowth of short-lived progeny of the various decay series isotopes.[8]
- Each sample will be analyzed by the methodology of gamma spectroscopy after an ingrowth period of at least 21 days, and with specified *a priori* detection levels of less than 0.5 pCi/g of Th-234, Bi-214, Pb-214 and Ac-228.
- At least 10% of the samples collected shall also be analyzed for isotopes of uranium and thorium by radiochemical extraction and alpha spectroscopy, with *a priori* detection levels of 0.1 pCi/g for each of the radionuclides.

The DQOs, for verification of Hudson Branch radioactivity activity are as follows:

- Verify the present-day activity concentration of the radionuclides of concern in sediments in the Hudson Branch watershed are similar to the concentrations noted during a 1991 sampling campaign.
- Establish the mean concentration for use in dose modeling using systematic measurements along the length of the watershed from the eastern-most border of the SMC property to the western-most location where samples were collected in 1991.
- Determine the general homogeneity of radionuclides along the length of the watershed streambed by performing walk-over surveys and correlating measurement results to radionuclide concentrations determined from the sampling effort.[9]
- Collect a total of 17 systematic samples, based on MARSSIM equation 5-2 and simplifying assumptions, to be used for a non-parametric statistical comparison of results to those from the 1991 sampling campaign.

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[8] The Ra-226 activity in the samples can thus be considered equal to the reported Bi-214 and Pb-214 activities after secular equilibrium is established. Likewise, the Ra-228 activity will be equal to the reported Ac-228 activity.

[9] If the radioactivity concentrations in the stream bed are non-homogeneous, a correlation between survey results and concentration, taking into account soil moisture content, may not be possible to a reasonable degree of scientific certainty.

- Collect biased samples from those locations exhibiting elevated exposure rates during the walkover surveys.[10]

- The sediments will be sampled from the surface of the sediment layer to a depth of 15 cm. (0.5 feet).

- Laboratory analysis will include determining percent moisture, homogenizing the sample, drying the sample, and sealing it into counting containers to allow for ingrowth of progeny.

- Each sample will be analyzed by gamma spectroscopy after an ingrowth period of at least 21 days using *a priori* detection levels of less than 0.5 pCi/g of Th-234, Bi-214, Pb-214 and Ac-228.

- At least 10% of the samples shall be analyzed by alpha spectroscopy for thorium and uranium isotopes with *a priori* detection levels of 0.1 pCi/g for each of the radionuclides.

The DQOs for the sampling along the fence line will be as follows:

- Verify whether licensed radioactivity is present in that location.

- Estimate the lateral and depth extent of the residual radioactivity.

- Establish the maximum concentration for comparison to applicable Derived Concentration Guideline Levels (DCGLs).

- Collect up to four (4) biased samples from those locations exhibiting elevated exposure rates during the walkover surveys.

- The samples will be collected from depths sufficient to ensure capture of the source of elevated exposure rate, to be determined by field screening of removed material.

- Laboratory analysis will include determining percent moisture, homogenizing the sample, drying the sample, and sealing it into counting containers to allow for ingrowth of progeny.

[10] These samples will be used in conjunction with the systematic measurements to determine the need for remediation of the Hudson Branch and establish the extent of residual radioactivity from licensed operations.

- Each sample will be analyzed by gamma spectroscopy after an ingrowth period of at least 21 days using *a priori* detection levels of less than 0.5 pCi/g of Th-234, Bi-214, Pb-214 and Ac-228.

- Each sample will be analyzed by alpha spectroscopy for thorium and uranium isotopes with *a priori* detection levels of 0.1 pCi/g for each of the radionuclides.

3 FIELD ACTIVITIES

3.1 Overview

In general, a series of tasks will be performed during the on-site portion of the sampling/measurement campaign. These are summarized as follows:

- Locate reference grid center point (using the coordinates in Table 6.5) for the collection of 17 systematic samples from the stockpile of soil (see Area 1 on Figure 7.2)
- Collect 17 systematic samples at a depth of 30 to 60 cm. (one to two feet) at the established collection points for the excavated soil.
- Locate reference grid center point (using the coordinates in Table 6.6) for the collection of 17 systematic samples from the stockpile of soil and demolition debris (Area 2 on Figure 7.2).
- Collect 17 systematic samples of the building debris at a depth of 30 to 60 cm. (one tot two feet) at the established collection points in Area 2.
- Locate reference grid center point (using the coordinates in Table 6.7) for the collection of 17 systematic samples each from the perimeter of the stockpile of building debris (Area 5 on Figure 7.2).[11]
- Collect 17 systematic samples of the building debris at a depth of 30 to 60 cm. (one to two feet) at the established collection points in Area 5.
- Establish systematic locations for collection of 17 sediment samples evenly-distributed across a pre-determined reach of the Hudson Branch, along the centerline using geolocation. Figure 7.3 provides a map showing the Hudson Branch; sample locations will be determined prior to sampling.
- Collect 17 systematic samples at a depth of 0 to 15 cm. (surface to 0.5 feet) at the established sampling points along the Hudson Branch.

[11] Building debris was placed around the perimeter of the slag pile, which extends into Area 5 from Area 4. Only sampling of the debris is necessary for this campaign.

- Perform walk-over surveys of the Hudson Branch using a 2 inch by 2 inch NaI(Tl) detector coupled to a rate meter and global positioning system (GPS), identify areas of elevated count rate (i.e., greater than twice the ambient background).[12]

- Collect biased samples at up to 10 additional locations along the Hudson Branch from the walk-over survey elevated measurement locations.

- Perform walk-over surveys of the Southwest fence line using a 2 inch by 2 inch NaI(Tl) detector coupled to a rate meter and global positioning system (GPS), identify areas of elevated count rate (i.e., greater than twice the ambient background). Figure 7.3 provides a map of the site taken from a previous investigation, showing the southwest fenceline.

- Collect biased samples at up to four (4) additional locations around the Southwest fence line from the walk-over survey elevated measurement locations. The sample depth will be sufficient to ensure the material/items contributing to the elevated exposure rates are sampled, as determined by field screening of excavated material. Samples will be collected at depths of 0 to 15 cm. (0 to 6 inches), 15 to 30 cm. (6 inches to 1 foot), and 30 to 60 cm. (1 to 2 feet), unless the field screening results show no residual radioactivity above background.[13]

- Collect duplicate samples at a minimum of 10% of the sample locations.

- Plot all measurement results and sampling locations on a survey map.[14]

- Package and ship samples to the pre-qualified laboratory for analysis.

- When all sample results are received, complete data reduction, analysis and report preparation.

[12] If the tree canopy prevents satellite communication with GPS system during the walk-over surveys, collection points will be recorded manually (on survey maps) in those instances.

[13] It may not be practical to continue sample collection if the field screening results indicate the potential presence of residual radioactivity at depths beyond two feet. The decision to continue sampling at depth or to defer additional investigation until a later date will be made by the project manager depending on professional judgement.

[14] Where possible, sample collection locations will be geolocated.

3.2 Health and Safety
A project health and safety plan will be in effect for the field activities. The following topics will be addressed in that plan:

- Scope
- Hazards
- Project Health and Safety Organization
- Personnel training
- ALARA
- Personal Protective Equipment Requirements
- Site Control
- Monitoring
- Decontamination
- Site Emergencies

3.3 Instrumentation and Sensitivity
All instrumentation used for the surveys, including scanning measurements, will be appropriate for the type of radiation expected, of sufficient sensitivity and accuracy to detect the radioactive materials of interest, and of sufficient quantity to support planned activities. Table 6.4 provides a list of the instrument types that will be used for implementation of this SAP, along with the types of radiations they detect, typical scan sensitivities, and the necessary calibration sources.

For surface soil, the project team will use a 2-inch by 2-inch sodium iodide gamma scintillator, such as a Ludlum Model 44-10, or equivalent. For contamination surveys, the project team will typically use a plastic scintillator detector of approximately 100 square centimeters in area, such as a Ludlum Model 43-93 or equivalent, for direct alpha measurements. A 15 square centimeter Geiger-Mueller (GM) detector, such as a Ludlum Model 44-9 or equivalent, will be used for contamination surveys of materials, equipment, and personnel. An appropriate ratemeter will be attached to the detectors, sufficient to provide the required voltage and if necessary, a scaler to accumulate total counts in a specified time period.

The walkover survey will use the IEM Land Area Survey Program (LASP). The LASP uses a global positioning system for precise data acquisition. Readings can thus be located *and re-located* to within six (6) inches. Position, time and radiation instrument read-outs will be acquired once per second and stored away for later processing. When the on-site work is complete, the data will be transferred directly into a computer-based Geographical Information System (GIS) that will display them in tabular form for statistical analysis. It will also provide the results in map form that will be laid over photographic images of the property.

3.4 Number of Samples

Equations for determining the number of measurements needed in order to make statistically-based decisions can be found in Chapter Nine of EPA Publication SW 846 and Chapter 5 of MARSSIM.[15,16] The approach in both guidance documents is similar, therefore the methodology proposed in MARSSIM, was selected because of its general acceptability by the USNRC. Although these samples are not Final Status Survey samples, the method in MARSSIM with some simplifying assumptions was used to estimate the minimum number of samples. The minimum number of samples needed is calculated using the formula for the sign test (equation 5-2 in MARSSIM) is determined as follows:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(Sign\ p - 0.5)^2}$$

where $Z_{1-\alpha}$ and $Z_{1-\beta}$ = the percentiles represented by the decision error levels α and β. In this calculation α and β are 0.05 and $Z_{1-\alpha}$ and $Z_{1-\beta}$ are each 1.645. The Sign P is determined from Table 5.4 in MARSSIM by the relative shift, Δ/σ, where Δ is the DCGL - LBGR, where the DCGL is the derived concentration guideline value, and the LBGR is the lower bound of the gray region (LBGR). MARSSIM allows the LBGR to be set at ½ of the DCGL.

Since there are no existing measurement data for the soil and the building rubble stockpiles, MARSSIM offers the following guidance: "When preliminary data are not obtained, it may be reasonable to assume a coefficient of variation on the order of 30%, based on experience." Therefore, the relative shift, Δ/σ, is calculated as (1-0.5)/(0.3) which equals 1.67. From there, MARSSIM Table 5-5 shows that a minimum of 17 samples are needed. This number includes a 20% increase in the number to account for uncertainty in the calculation of N and for the possibility of there being unusable data.

3.5 Systematic Sampling Locations

Where *systematic sampling* is to be performed, a grid system will establish the sample locations. The grid system will be based on dividing the area of concern into 17 equal-area sectors and establishing the center point of the sector. . Figure 7.2 shows the Storage Yard with Areas 1, 2, and

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[15] EPA Publication SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," November 2004.

[16] NUREG 1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

5 divided into 17 sectors of equal area and the center point of each. Tables 6.5, 6.6, and 6.7 contain the coordinates for the center point of each sector where the sample will be collected. If accessibility or other issues require an alternate collection point within a given sector, the collection will be re-located as close as possible to the original point and the coordinates for the alternate location recorded.

3.6 Sample Collection and Analysis

Sample collection locations will be determined either by preset systematic locations or based on field surveys. Samples will be collected at the specified depths using the guidance contained in IEM procedure RSP-026, "Sample Collection". Approximately one (1) kilogram of sample will be collected from each location. The sample will be marked with a unique (predetermined) identifier, the date and time the sample was taken, and the initials of the individual obtaining the sample.

Samples will be packaged, a chain of custody form completed and sent by overnight mail to the laboratory for analysis. Each sample will be prepared by the laboratory (% moisture determined, sample dried, homogenized and sealed) and after a sufficient time for ingrowth to establish equilibrium between Ra-226, Rn-220, and Bi-214, each sample will be counted by gamma spectroscopy.

Ten (10) percent (randomly-selected) of the samples collected from each area will also be analyzed for uranium and thorium isotopes by radiochemical extraction and alpha spectroscopy. The aliquot for isotopic thorium and isotopic uranium will be obtained from the original sample prior to sealing it for preparation for gamma spectral analysis.

3.7 Systematic Sampling in Storage Yard

3.7.1 Excavated Soil Stockpile

The area and distribution of the excavated soils within the Storage Yard will be determined. A reference grid of 17 equally-spaced sectors will be initially established over the surface of the stockpile using the coordinates shown in Table 6.5, as uploaded into a GPS device. A labeled wooden stake or pin flag will be placed at each collection location. Seventeen (17) samples, each with a volume of approximately 0.5 liters, will be collected at the established locations, from a depth of between 30 cm. and 60 cm. (one to two feet).

All soil samples will be collected with a decontaminated stainless steel bucket auger. The upper 30 cm. of soil will be discarded adjacent to the boring. The soil from the 30 cm. to 60 cm. depth interval will be placed into a stainless steel mixing bowl and homogenized with a decontaminated stainless steel spoon. After homogenization, the soil will be placed directly into laboratory-supplied containers. Exposure rate measurements will be recorded at each collection location prior to and during sample collection.

At 10% of the locations (i.e., two sectors), a duplicate Quality Control sample will be collected. The duplicate sample will be labeled as QC in project records only (not on the chain of custody form), but will otherwise be handled, shipped and analyzed the same way as all other samples.

The sample set will then be logged, and prepared for shipment to the offsite laboratory. A chain of custody form will be completed and the samples will be shipped with analysis instructions to the offsite laboratory.

3.7.2 Building Debris Stockpiles

The area and distribution of the building debris within Areas 2 and 5 of the Storage Yard will be determined (see Figure 7.2). A 17- equal area reference grid (or other means of establishing systematic samples due to accessibility issues) will be established over each of the stockpiles. Seventeen (17) samples, each with a volume of approximately 0.5 liters, will be collected at the established locations.

At 10% of the locations a duplicate Quality Control sample will be collected. The duplicate sample will be labeled as QC in project records only, but will otherwise be handled, shipped and analyzed the same way as all other samples.

The sample set will then be logged, and prepared for shipment to the offsite laboratory. A chain of custody form will be completed and the samples will be shipped with analysis instructions to the offsite laboratory.

3.8 Hudson Branch Sediments

The area and length of the Hudson Branch to be investigated will be determined by comparison to the 1991 ENSR report. The locations for 17 samples will be established by evenly spacing the collection points along the applicable length of the Hudson Branch using a hand-held GPS device.

Seventeen (17) samples, each with a volume of approximately 0.5 liters, will be collected at a depth of 0 to 15 centimeters, at the established locations. The sediment samples will be collected with a decontaminated stainless steel trowel from depositional areas within the stream. The sediment will be placed directly into a stainless steel mixing bowl and homogenized with a decontaminated stainless steel spoon. After homogenization, the sediment will be placed directly into the laboratory-supplied containers. The sediment samples will be collected in a downstream to upstream fashion to minimize impacts of sediment disturbances on subsequent sampling locations.[17]

[17] If the sample is very wet, additional sample volume may be needed to ensure adequate sample after drying for analysis.

At 10% of the locations (i.e., two (2) locations), a duplicate Quality Control sample will be obtained. The duplicate sample will be labeled as QC in project records only, then labeled, packaged, shipped and analyzed the same as all other samples.

The sample set will be logged, and prepared for shipment to the offsite laboratory. A chain of custody form will be completed and the samples will be shipped with analysis instructions to the offsite laboratory.

3.9 Gamma Scanning and Biased Sampling Along the Hudson Branch

The accessible area along the Hudson Branch will be surveyed using IEM's LASP equipment. At 10 of the locations that exhibit the highest measured exposure rates during the walkover survey, samples will be collected and the collection location recorded.

Samples will each have a volume of approximately 0.5 liters. At 10% of the locations a duplicate Quality Control sample will be obtained. The duplicate sample will be labeled as QC and sampled and analyzed the same as all other samples.

The sample set will be logged, and prepared for shipment to the offsite laboratory. A chain of custody form completed and the samples will be shipped with analysis instructions to the offsite laboratory.

3.10 Southwest Fenceline Investigation

The area along the Southwest Fenceline, previously identified as elevated, will be surveyed using IEM's LASP equipment in an attempt to re-locate and outline the area of elevated exposure rate identified in the 1991 measurement campaign by ENSR. Up to four (4) sample collection locations will be established at points that exhibit the highest surface measurement. The sample collection depth will be sufficient to ensure the material/items contributing to the elevated surface exposure rates is included, which will be determined by field screening of the removed material. Samples will be obtained from depths of 0 to 15 cm. (0 to 6 inches), 15 to 30 cm. (6 inches to 1 foot), and 30 to 60 cm. (1 to 2 feet), unless the field screening measurements of the samples are indistinguishable from background.

The samples will each have a mass of approximately 0.5 liters. Each will be logged, and prepared for shipment to the offsite laboratory. A chain of custody form completed and the samples will be shipped with analysis instructions to the offsite laboratory.

4 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance and quality control will be maintained by the use of approved plans and procedures, training and qualification, instrument control and response testing, and laboratory quality control.

4.1 Procedures

Sampling, surveys, instrument response tests, instrument use, and documentation will be controlled by IEM's procedures. Those deemed applicable to the project are listed as follows:

- RSP-004, Radiation Protection Records
- RSP-006, Training and Qualifications of Radiation Protection Personnel
- RSP-007, Training in Radiation Protection
- RSP-008, Instrumentation
- RSP-009, Contamination Control
- RSP-010, Exposure Control
- RSP-012, Control of Radiological Work
- RSP-013, Control of Radioactive Waste
- RSP-015, Packaging and Transportation of Radioactive Material
- RSP-018, Surveillance
- RSP-020, Tailgate Safety Training
- RSP-026, Sample Collection
- RSP-031, Health and Safety Planning
- RSP-033, Changing Count Time on the Ludlum 2241 Scaler
- RSP-035, Operation of the Trimble Backpack Gamma Survey System

A controlled copy of each procedure will be maintained on-site by the Project Manager for the duration of the on-site work.

4.2 Sample Documentation and Chain of Custody

Each sample will be marked and logged with a unique sample identification, sample depth, the date and time sampled, and the initials of the individual who obtained the sample. The locations of the samples will be recorded on a survey map and or by GPS. The individual who collects each sample will be responsible for sample custody from the time of sample collection until transfer to a commercial carrier. A sample is considered to be under custody under the following circumstances:

- The sample is in a person's possession.
- The sample is in that person's view after being in his or her possession.
- The sample was in that person's possession and then placed in a secured location.
- The sample is in a designated secure area.

Sample containers that are shipped together in a group will be assigned a single Chain-of-Custody Record, which will be included in the coolers sent to the laboratory. A signed copy of the Chain-of-Custody Record will be retained by the Project Manager before the coolers are shipped to the laboratory. The shipment air bill will be maintained by the Project Manager as part of the Chain-of-Custody documentation.

4.3 Instrument Quality Control

The sensitivity of each instrument used during the field portion of this effort will be determined prior to the start of the sampling and measurement campaign. Instrument response testing will include a daily source check.[18] All source check results will be documented. Failed source checks will be repeated. Consecutive failure will result in additional testing of the instrument, in accordance with the applicable procedure, and ultimately in removing the counting system from service.

Survey data acquired prior to an instrument failing a source check will be reviewed by the Project Manager to determine the validity of the data. This review will be documented.

All instrument failures in the field will be followed by an investigation by the Project Manager of suspect data. All investigations and findings will be documented.

[18] For field instrumentation, source check acceptance criteria (e.g., ±2 sigma for direct [integrated] measurements and ±20 percent for rate measurements, or as otherwise specified in the instrument procedure of vendor manual) will be established prior to beginning the project.

All counting systems and instruments will be calibrated using National Institute of Standards and Technology (NIST) traceable source at intervals not exceeding 12 months for portable field survey instruments. The source used for calibrations will be appropriate for the type and the energy of the radiation to be detected. All calibrations will be documented and will include the source data.

4.3 Sample Analysis Laboratory and Quality Control Samples

A commercial lab with a Quality Assurance (QA) plan, and a State of New Jersey Department of Environmental Protection NELAC (National Environmental Accreditation Conference) accreditation, will be selected to analyze the soil and sediment samples. Prior to submitting any samples to the commercial analytical laboratory, IEM will write a letter of specification to the laboratory and a purchase order for services. This letter will include the necessary measurement results and relevant detection sensitivities. At that time, the laboratory will be asked to declare the analytical methods and measurement devices they intend to use in order to meet IEM's specifications.

The commercial laboratory that provides analytical results as part of this sampling effort will be asked to provide a copy of their quality assurance documents, including quality assurance procedures designed to ensure that the necessary calibrations and detection sensitivity requirements are met. In addition to the analytical requirements, the letter of specification will describe the following criteria:

- Sample radionuclides to be reported for gamma spectroscopy will include U-238 (Th-234), Th-232 (Ac-228), and Ra-226(Bi-214 and Pb-214). The case narrative will specify when and how the samples were prepared, how the samples were sealed to prevent escape of radon, the time that the samples were allowed for ingrowth of radon progeny, and the assumed fraction of equilibrium between Ra-226 and Bi-214/Pb-214.

- Sample radionuclides to be reported for alpha spectroscopy will include U-238, U-234, and U-235 for isotopic uranium and, Th-232, Th-228, and Th-230 for isotopic thorium analysis.

- MDAs must be no greater than 0.5 pCi/g for each radionuclide analyzed by gamma spectroscopy and 0.1 pCi/g for each of the uranium and thorium isotopes analyzed by alpha spectroscopy.

- Sample disposition (i.e., turnaround time required to support the project; and proper maintenance, storage, and archiving of samples after transfer to laboratory).

- Handling of duplicate QC Samples.[19]

The number and types of analytical QC samples for a specific laboratory analysis will be as specified in the analysis laboratory's QA manual. These QC samples will include duplicate samples and spiked samples with site media containing a known quantity of one or more radionuclides. The results of these QA/QC samples will be reviewed by the Project Manager to assess the accuracy and precision of the laboratory counting system as follows:

- The results of duplicate samples will be reviewed against the original analysis results.
- The results of spiked samples will be reviewed against the known value.
- The results of the blank sample analysis will be reviewed against the desired Minimum Detectable Concentrations (MDCs) for the specified radionuclides. The MDCs reported should be less than the desired MDCs.

[19] A duplicate sample will be collected at approximately 10% of the sample locations. These duplicate samples will be prepared and analyzed in the same manner as the field samples. If the activity concentration in the samples is greater than three times the detection level the duplicate and the original sample will be compared by determining the relative percent difference.

5 RECORDS AND REPORTS

5.1 Records

All records pertinent to this SAP will be maintained pursuant to IEM Procedure No. RSP 004, "Radiation Protection Records". Field records will contain the following, at a minimum:

- A description of the purpose of the sampling and survey (i.e., a copy of this plan).
- The name(s) of the sampling and survey personnel and their qualifications.
- A description of the survey methodology.
- Sufficient information and data to enable an independent re-creation and evaluation of sampling and survey activities and results.
- Copies of all Radiological Survey Forms, instrument check sheets, and calculation forms as required in RSP-008, "Instrumentation" and RSP-018, "Surveillance," or equivalent.
- Survey maps will designate the location surveyed/sampled, as well as the name of the surveyor and other pertinent survey information.

Both direct field measurements and laboratory analytical results for radiological monitoring and soil sampling will be documented. The results for each sample analysis will be listed in tabular form along with the corresponding grid block or coordinate location. All survey data will be recorded in a verifiable manner and reviewed for accuracy and consistency.

Data acquired during the implementation of the SAP will be captured as part of a data management system. Chain-of-custody (COC) records will be completed and COC procedures followed.

5.2 Data Reduction

An evaluation will be made to confirm that the required number of samples were taken. The walk-over gamma scan measurements will be reviewed to select biased measurement locations. For each survey area, basic statistical quantities will be calculated as follows:

- Mean
- Standard deviation
- Median

- Minimum
- Maximum

The Wilcoxon Rank Sum (WRS) test or equivalent test such as the Mann-Whitney U test will be used to evaluate the Hudson Branch sample analysis results against those acquired by ENSR in 1991. The null hypothesis for use of the WRS test is H_0: there is no difference in the distribution of sample results from the 1991 sample data to the sample data collected here. If the null hypothesis is accepted it will be concluded that the sample activity within the Hudson Branch has not changed. If the statistical analysis shows that the data have changed (i.e., the null hypothesis is rejected), the results will be evaluated to determine if the activity concentrations have increased or decreased.

5.3 Report

A report of this sampling and analysis effort will be prepared summarizing the activities and results. Information from the sampling of Storage Yard materials combined with the existing data for slag and baghouse dust will be used as the basis for the development of a Source Term Document, that will define the radionuclide concentrations for the materials to be consolidated into the SMC restricted area cell.

The Report will be a stand-alone document, with the amount of information incorporated by reference being kept to a minimum. The report will be reviewed and approved by personnel capable of evaluating all aspects of the survey/sampling but not responsible for the implementation of any portion of this SAP. The required report elements are as follows:

- Site description
- Site conditions at the time of the survey
- Survey objectives
- Selection of instruments and survey techniques
- Detection sensitivity
- Survey plan and procedures
- Scanning survey measurements
- Discrete samples
- Sample collection and analysis

- Data interpretation
- A discussion of any field modifications that were made in the implementation of the survey and sampling effort from what was described in this SAP
- The number of samples collected from each area.
- A drawing of each survey area showing the reference grid system
- The measured sample concentrations
- The statistical evaluation of the measured concentrations
- Biased (judgmental) and miscellaneous sample data sets will be reported separately from those samples collected using a systematic grid system
- A discussion of anomalous data, including any areas of elevated direct radiation detected during scanning.

6 TABLES

Table 6.1 - Data Summary and Sample Additions

Material	Summary Statistics	Th-232	Ra-226	U-238	Additional Samples Required
Slag	mean (pCi/g)	425	103	224	0
	median (pCi/g)	322	86	209	
	standard dev. (pCi/g)	414	92	184	
	number of measurements	39	36	33	
	$t_{.025}$ (95% CL)	1.96	1.96	1.96	
	UCL of mean (95%) (pCi/g)	555	133	287	
Baghouse Dust	mean (pCi/g)	40	19	15	0
	median (pCi/g)	39	19	15	
	standard dev. (pCi/g)	28	10	8	
	number of measurements	24	9	24	
	$t_{.025}$ (95% CL)	2.069	2.306	2.069	
	UCL of mean (95%) (pCi/g)	51	27	19	
Excavated Soil	-	-	-	-	17
Building Material Debris	-	-	-	-	34

Table 6.2 - Thorium Decay Series

Radionuclide	Half Life	Major Radiation Energies (MeV) and Yield (%)					
		Alpha		Beta (Emax)		Gamma	
Thorium-232	1.4 E10 years	3.95 4.01	23% 77%				
Radium-228	5.75 years			0.06	100%		
Actinium-228	6.1 hours			1.17 1.74	32% 12%	0.388 0.911 0.969	11% 28% 17%
Thorium-228	1.9 years	5.34 5.42	27% 73%				
Radium-224	3.6 days	5.45 5.69	5% 95%			0.241	4%

Only radionuclides important to the quantification are shown in the table

Table 6.3 - Uranium Decay Series

Radionuclide	Half Life	Major Radiation Energies (MeV) and Yield (%)					
		Alpha		Beta (Emax)		Gamma	
Uranium-238	4.47 E9 years	4.15 4.20	23% 77%				
Thorium-234	24.1 days			0.10 0.19	19% 73%	0.063 0.0928	4% 5%
Protactinium-234m	1.17 minutes			2.29	98%	1.00	0.6%
Uranium-234	2.44 E5 years	4.72 4.77	27% 72%			0.053	0.1%
Thorium-230	7.77 E4 years	4.62 4.68	28% 76%			0.067	0.4%
Radium-226	1.60 E3 years	4.60 4.78	6% 94%			0.186	5%
Pb-214	26.8 minutes			0.672 0.729	48% 43%	0.295 0.352	19% 37%
Bi-214	19.9 minutes					0.609 1.120	46% 15%

Only radionuclides important to the quantification are shown in the table

Table 6.4 - Radiation Survey Instruments

Make	Ratemeter Model	Detector Model	Detector Type	Radiation Detected	Calibration Source	Sensitivity (1)	Use
Ludlum	2241	44-10	2 by 2 inch NaI(Tl)	Gamma	Cs-137 (γ)	1.8 pCi/g Th-232 80 pCi/g processed Natural Uranium	Scanning surface soil
Ludlum	2224	43-93	Dual Scintillatio n	Alpha or Beta	Th-230 (α) Tc-99 (β)		Direct alpha surveys on solid surfaces including tools and equipment
Ludlum	3	44-9	Geiger Mueller	Beta	Tc-99 (β)	100 cpm	Direct alpha surveys on solid surfaces including tools and equipment
Bicron	Microrem	-	Plastic Scintillator	Gamma	Cs-137 (γ)		Scanning surface soil/dose rate measure ments

Sensitivity values are based on equations in MARSSIM and NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions.* Sensitivity values here assume an observation interval of 1 second and a decision error, d' =1.38. The 44-10 sensitivity was taken from Table 6.4 of NUREG-1507 and assumes a background count rate of 10,000 cpm. The 44-9 sensitivity was calculated using MARSSIM equations 6-8 and 6-9 assuming a background count rate of 100 cpm.

Table 6.5 - Area 1 - Systematic Sample Point Coordinates

Sample Point	Coordinates		Coordinates	
	Northing	Easting	Latitude	Longitude
1	257731.4595	1901442.1366	39.2602	-69.3041
2	257773.5700	1901438.4299	39.2602	-69.3041
3	257794.8753	1901450.7924	39.2602	-69.3041
4	257808.7796	1901467.7173	39.2603	-69.3040
5	257822.6974	1901486.5954	39.2603	-69.3040
6	257838.8732	1901506.9368	39.2603	-69.3040
7	257857.6269	1901529.0412	39.2603	-69.3040
8	257875.5357	1901561.1979	39.2603	-69.3039
9	257893.0864	1901598.3958	39.2603	-69.3039
10	257835.3764	1901605.3554	39.2603	-69.3039
11	257812.6342	1901593.4281	39.2603	-69.3039
12	257785.4786	1901585.3260	39.2602	-69.3039
13	257765.4869	1901573.4751	39.2602	-69.3039
14	257753.0001	1901556.4165	39.2602	-69.3039
15	257742.2158	1901534.9561	39.2602	-69.3040
16	257728.1839	1901510.2992	39.2602	-69.3040
17	257711.5314	1901479.1625	39.2602	-69.3040

Table 6.6 - Area 2 - Systematic Sample Point Coordinates

Sample Point	Coordinates		Coordinates	
	Northing	Easting	Latitude	Longitude
18	257783.9779	1901656.2890	39.2602	-69.3038
19	257769.9878	1901667.7501	39.2602	-69.3038
20	257759.9441	1901657.2743	39.2602	-69.3038
21	257746.4891	1901654.0220	39.2602	-69.3038
22	257728.3535	1901651.8606	39.2602	-69.3038
23	257712.6443	1901648.3678	39.2602	-69.3038
24	257703.5948	1901636.0782	39.2601	-69.3038
25	257704.9997	1901617.2529	39.2602	-69.3039
26	257698.2718	1901605.6978	39.2601	-69.3039
27	257697.0631	1901593.7188	39.2601	-69.3039
28	257694.2210	1901580.4102	39.2601	-69.3039
29	257694.1307	1901561.2778	39.2601	-69.3039
30	257720.4789	1901625.3445	39.2602	-69.3039
31	257739.1492	1901629.4661	39.2602	-69.3038
32	257754.6244	1901626.4997	39.2602	-69.3038
33	257768.2639	1901625.2860	39.2602	-69.3038
34	257777.5035	1901637.5587	39.2602	-69.3038

Table 6.7 - Area 5 - Systematic Sample Point Coordinates

Sample Point	Coordinates		Coordinates	
	Northing	Easting	Latitude	Longitude
35	258024.8220	1901649.4602	39.2605	-69.3038
36	258057.1398	1901656.6954	39.2605	-69.3038
37	258035.4506	1901681.2795	39.2605	-69.3038
38	258029.0227	1901701.6698	39.2605	-69.3037
39	258022.3050	1901724.3544	39.2605	-69.3037
40	258016.5926	1901748.9187	39.2605	-69.3037
41	258014.9795	1901774.5509	39.2604	-69.3036
42	257960.6741	1901779.7954	39.2604	-69.3036
43	257960.3195	1901758.9847	39.2604	-69.3037
44	257962.4984	1901739.3958	39.2604	-69.3037
45	257969.3226	1901718.9602	39.2604	-69.3037
46	257972.8529	1901697.2511	39.2604	-69.3037
47	257974.7076	1901676.8707	39.2604	-69.3038
48	257976.4151	1901657.6622	39.2604	-69.3038
49	257977.1972	1901639.4682	39.2604	-69.3038
50	257971.7396	1901621.5890	39.2604	-69.3038
51	257962.3596	1901599.4164	39.2604	-69.3039

7- FIGURES

Figure 7.1 - Newfield Site Plan

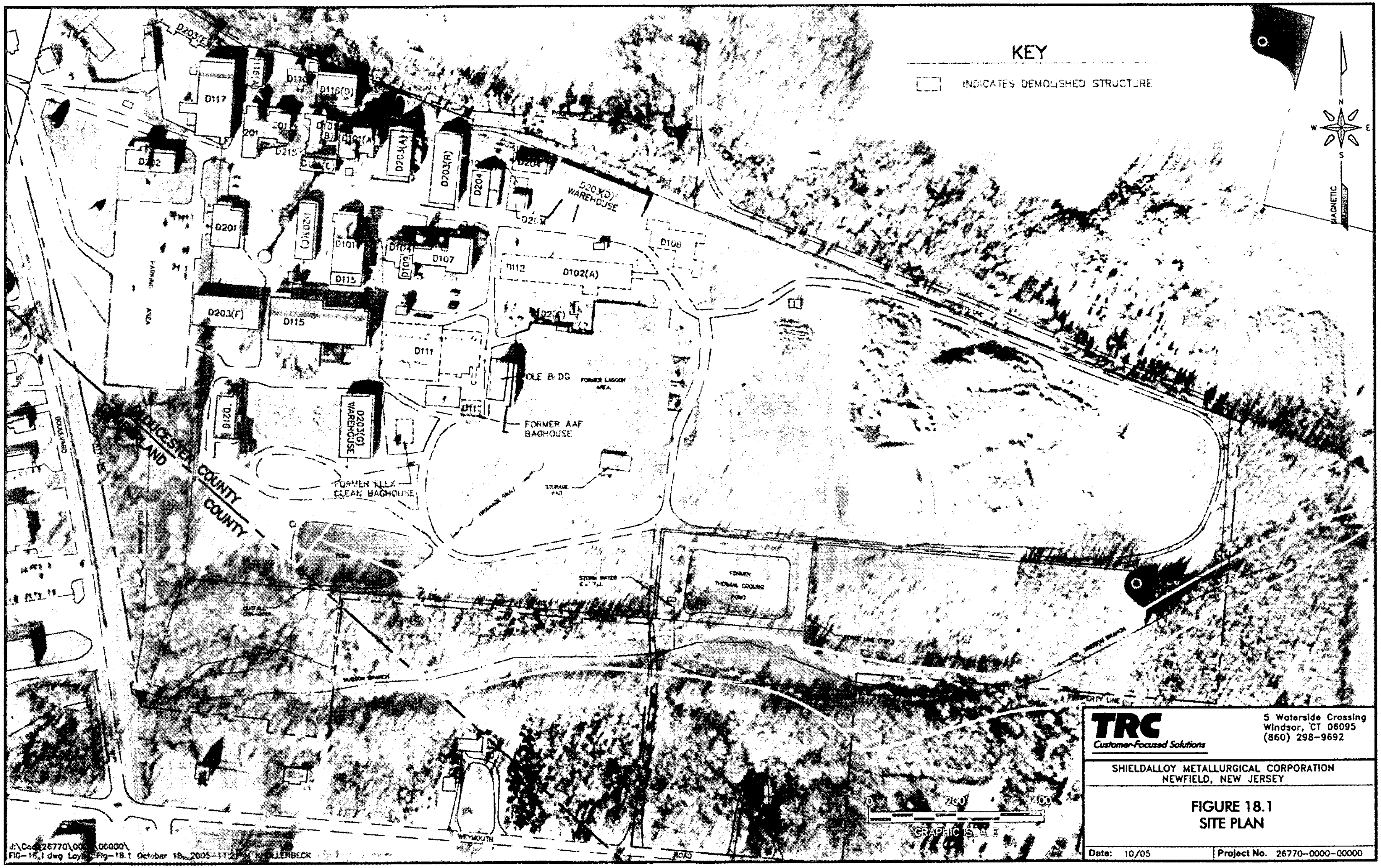
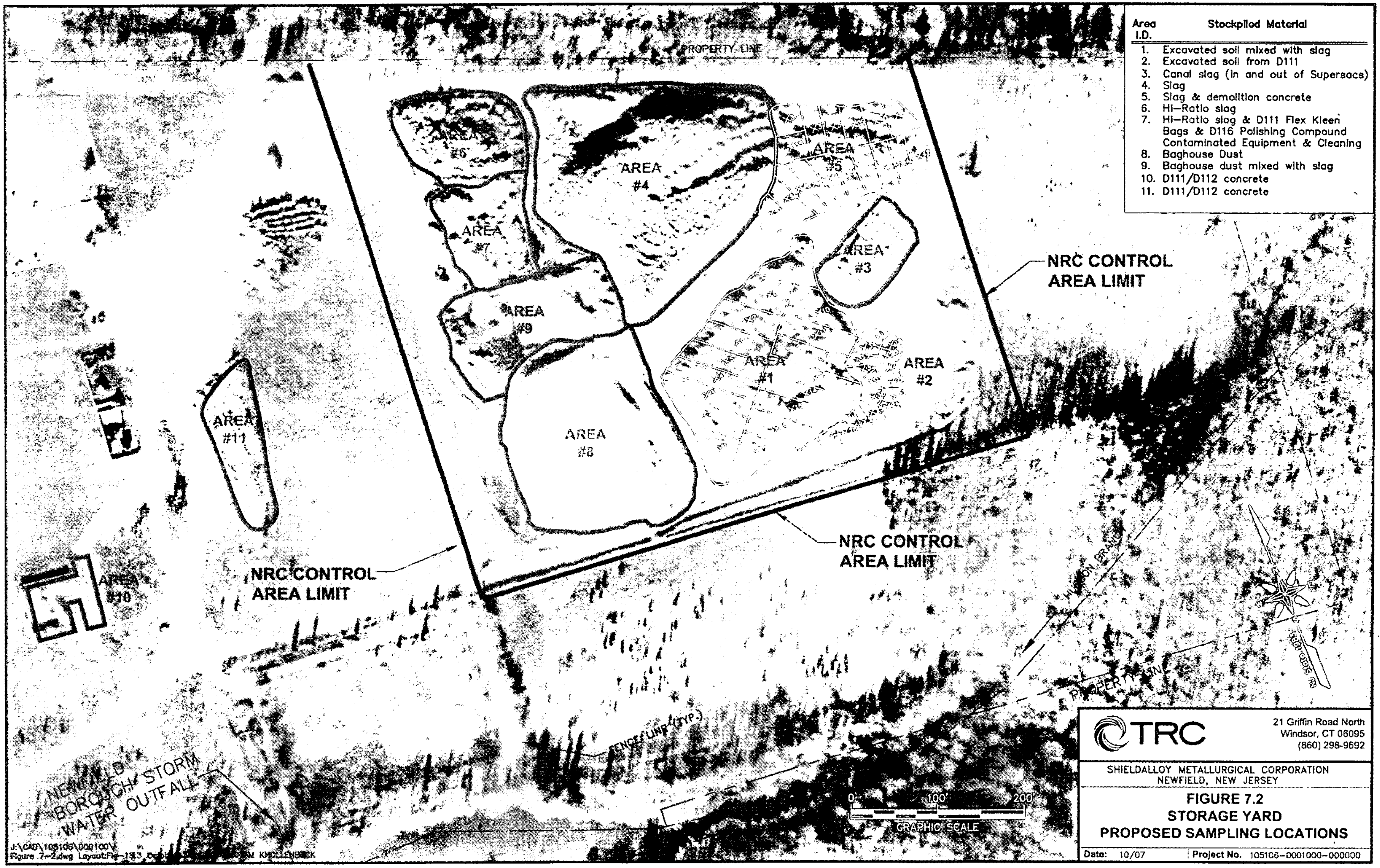

KEY
INDICATES DEMOLISHED STRUCTURE
N
E
S
W
MAGNETIC
D117
D202
D201
D203(F)
D115
D116(D)
D101(A)
D203(A)
D203(B)
D204
D215
D203(C)
D101
D107
D112
D102(A)
D106
D111
D210
D203(G) WAREHOUSE
D203(D) WAREHOUSE
D203(E)
POLE BLDG
FORMER AAF BAGHOUSE
FORMER FLEX CLEAN BAGHOUSE
PARKING AREA
GLOUCESTER COUNTY
CUMBERLAND COUNTY
FORMER THERMAL COOLING POND
PROPERTY LINE
WEYMOUTH
GRAPHIC SCALE
0
200'
400'
TRC
Customer-Focused Solutions
5 Waterside Crossing
Windsor, CT 06095
(860) 298-9692
SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
FIGURE 18.1
SITE PLAN
Date: 10/05
Project No. 26770-0000-00000

Figure 7.2 - Storage Yard - Proposed Sampling Locations



TRC
21 Griffin Road North
Windsor, CT 06095
(860) 298-9692

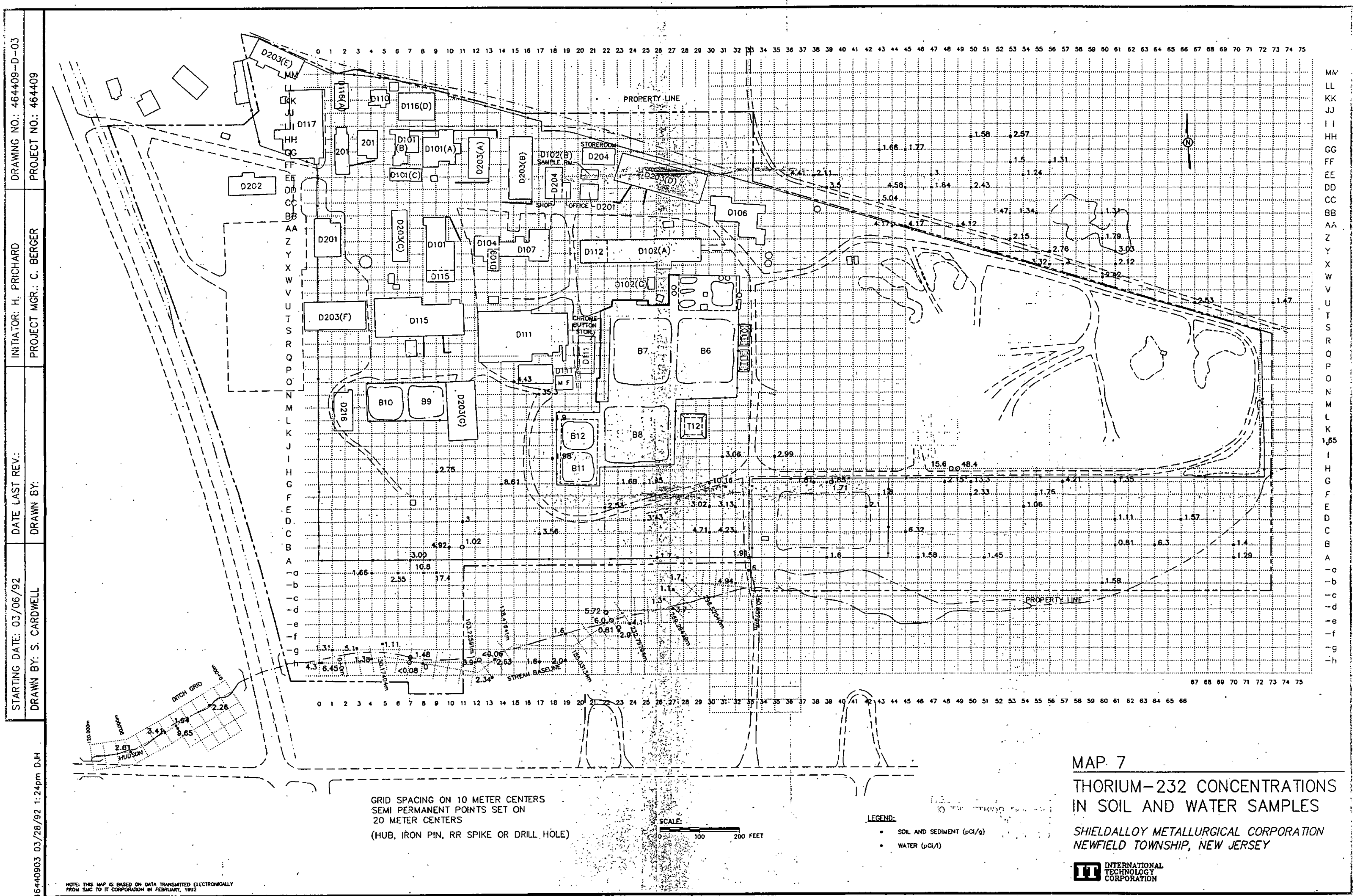
SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

FIGURE 7.2
STORAGE YARD
PROPOSED SAMPLING LOCATIONS

Date: 10/07 | Project No. 105106-0001000-000000

J:\CAD\105106\000100\Figure 7-2.dwg Fig-18.3, 10/31/2007 9:07:53 AM, KHOLLENBECK

Figure 7.3 - Newfield Site Map Showing Hudson Branch and Southwest Fenceline



DRAWING NO.: 464409-D-03
PROJECT NO.: 464409
INITIATOR: H. PRICHARD
PROJECT MGR.: C. BERGER
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 03/06/92
DRAWN BY: S. CARDWELL
46440903 03/28/92 1:24pm DJH
PROPERTY LINE
STOREROOM
SAMPLE RM.
SHOP
OFFICE
CHROME BUTTON STORE
STREAM BASELINE
DITCH GRID
HUDSON
GRID SPACING ON 10 METER CENTERS
SEMI PERMANENT POINTS SET ON
20 METER CENTERS
(HUB, IRON PIN, RR SPIKE OR DRILL HOLE)
SCALE:
0 100 200 FEET
LEGEND:
SOIL AND SEDIMENT (pCi/g)
WATER (pCi/l)
MAP 7
THORIUM-232 CONCENTRATIONS
IN SOIL AND WATER SAMPLES
SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD TOWNSHIP, NEW JERSEY
INTERNATIONAL TECHNOLOGY CORPORATION
NOTE: THIS MAP IS BASED ON DATA TRANSMITTED ELECTRONICALLY FROM SMC TO IT CORPORATION IN FEBRUARY, 1992

8 APPENDICES

Appendix 8.1 - Historical Data Review

This appendix is a summary of previous investigations of the radionuclide concentrations of material in the Storage Yard that will be consolidated during decommissioning. Specifically, the following are the results of investigations of slag and baghouse dust constituents:

- Oak Ridge Associated Universities (ORAU) performed a study of the SMC Newfield site in 1987. This study included samples of soil, water sediments, slag and baghouse dust as reported in *Radiological Survey of the Shieldalloy Corporation Newfield, New Jersey*, J.D. Berger and A.D. Luck, ORAU 88/G-79, July 1988. Thirty (30) slag samples and four (4) baghouse dust (BHD)samples were analyzed by ORAU during this effort.

- SMC obtained seven (7) slag samples in July and August 1994. These samples were analyzed by EcoTec laboratory and the results reported in an October 3, 1994 Letter from Carol D. Berger to C. Scott Eves, SMC, Re: SLAG Sampling Program Summary.

- SMC obtained two (2) samples of slag in November 1994. These samples were analyzed by EcoTec laboratory and the results reported in a January 12, 1995 Letter from Carol D. Berger to C. Scott Eves, SMC, Re: CANAL Sampling Program Summary.

- Oak Ridge Institute for Science and Education (ORISE) Environmental Survey and Site Assessment Program (ESSAP) obtained four (4) samples of baghouse dust in 1997. These samples were analyzed by gamma spectroscopy and results for U-238, Ra-226, Th-232, Th-228, and reported in an October 14, 1997 letter from Dale Condra, Technical Resources Manager, ESSAP, to Marie Miller, U.S. NRC Region I, Subject: Report for Analysis of Dust Samples from Shieldalloy Metallurgical Corporation, Newfield, New Jersey (RFTA No. 97-24).

- IEM obtained fifteen (15) samples of baghouse dust in 1995. These samples were analyzed for thorium and uranium ppm at the University of Missouri. The results are reported in a September 11, 1995 letter from Carol D. Berger, IEM to C. Scott Eves, SMC, Re: Radiological Constituents in Samples Collected from the Lime Pile. The ppm results were converted to activity concentration (pCi/g) using the equations below. The thorium ppm was assumed to be 100% Th-232, the uranium ppm was assumed to be 100% U-238. Converting U-238 ppm to U-238 pCi/g, [ppm = µg/g] as follows:

$$U\text{-}238\ ppm \times \frac{\mu g}{g} \times \frac{g}{1e{+}06\ \mu g} \times \frac{6.023e{+}23\ atom}{mole} \times \frac{mole\ U\text{-}238}{238g}\ \frac{\ln 2}{4.468e{+}09\ yr \times 3.156e{\pm}07\ s/yr} \times \frac{pCi}{0.037\ d/s}$$

gives 0.336456 pCi/g. Converting Th-232 ppm to Th-232 pCi/g as follows:

$$Th\text{-}232\ ppm \times \frac{\mu g}{g} \times \frac{g}{1e{+}06\ \mu g} \times \frac{6.023e{+}23\ atom}{mole} \times \frac{mole\ Th\text{-}232}{232g}\ \frac{\ln 2}{1.405e{+}10\ yr \times 3.156e{\pm}07\ s/yr} \times \frac{pCi}{0.037\ d/s}$$

gives 0.109690 pCi/g.

Table 8.1a - Slag Radionuclide Concentrations

Report	Source	Location		Radionuclide concentration (pCi/g)						Analysis	Notes
		N	E	Th-232	Th-232 error	Ra-226	Ra-226 error	U-238	U-238 error	Lab	
ORAU	Table 6	71	48	1.8	0.9	0.7	0.7	<1.8		ORAU	1
ORAU	Table 6	70	44	1460	20	110	7	<98		ORAU	
ORAU	Table 6	64	39	3.9	1.1	4.3	0.6	<2.0		ORAU	
ORAU	Table 6	70	30	542	10	114	5	<58		ORAU	
ORAU	Table 6	67	15	263	6	96.1	3.6	119	80	ORAU	
ORAU	Table 6	72	18	683	17	243	9	700	260	ORAU	
ORAU	Table 6	85	16	181	7	51.4	3.7	66	43	ORAU	
ORAU	Table 6	86	12	240	7	86.1	3.7	107	81	ORAU	
ORAU	Table 6	88	30	263	8	24.8	3.1	<49		ORAU	
ORAU	Table 6	89	30	0.5	0.8	0.5	0.8	1.5	3	ORAU	
ORAU	Table 6	79	35	586	6	79.9	2.2	44	65	ORAU	
ORAU	Table 6	85	47	173	3	12.1	1	11.2	6.4	ORAU	
ORAU	Table 7	70	65	659	11	267	6	430	170	ORAU	2
ORAU	Table 7	50	68	706	13	247	7	280	150	ORAU	
ORAU	Table 7	30	80	0.6	0.3	0.5	0.1	0.8	1.3	ORAU	
ORAU	Table 7	18	90	1500	20	105	7	130	160	ORAU	
ORAU	Table 7	20	98	1340	22	185	8	480	160	ORAU	
ORAU	Table 7	30	110	10.9	1.4	2.5	0.6	1.9	2.6	ORAU	
ORAU	Table 7	46	110	683	14	270	8	280	190	ORAU	
ORAU	Table 7	61	131	137	5	23.4	1.5	24	15	ORAU	
ORAU	Table 7	78	126	482	11	187	6	340	160	ORAU	
ORAU	Table 7	80	100	393	7	118	4	159	94	ORAU	
ORAU	Table 7	75	80	1500	20	23.6	5.1	520	180	ORAU	
ORAU	Table 7	74	68	13.8	2.1	2.9	0.9	6.8	3.7	ORAU	
ORAU	Table 7	45	100	472	7	318	5	310	130	ORAU	
ORAU	Table 7	52	110	219	7	85.6	3.8	209	92	ORAU	
ORAU	Table 7	64	110	93.7	5.8	44	3.1	70	68	ORAU	
ORAU	Table 7	65	90	3.5	0.9	2.5	0.7	<1.9		ORAU	
ORAU	Table 7	78	115	671	10	198	5	300	120	ORAU	
ORAU	Table 7	35	87	412	8	140	4	94	110	ORAU	
IEM/SMC	SMC-7-29-94-1		1	354	52.6	74.5		347	42.9	EcoTec	3
IEM/SMC	SMC-7-29-94-2		2	470	77.2	not reported		408	50.7	EcoTec	

Report	Source	Location		Radionuclide concentration (pCi/g)						Analysis	Notes
		N	E	Th-232	Th-232 error	Ra-226	Ra-226 error	U-238	U-238 error	Lab	
IEM/SMC	SMC-7-29-94-3		3	501	65.4	not reported		409	51	EcoTec	
IEM/SMC	SMC-8-1-94-1		4	317	42.1	80.6	9.48	323	40.1	EcoTec	
IEM/SMC	SMC-8-1-94-2		5	322	40.8	68.2	8.03	323	41	EcoTec	
IEM/SMC	SMC-8-1-94-3		6	401	53	90.3	9.3	455	57.4	EcoTec	
IEM/SMC	SMC-8-1-94-4		7	304	37.8	105	10.5	301	38.5	EcoTec	
SMC	GFe-FeCb Slag 10/20/1994			109	14.1	238	62.5	95.1	12.6	EcoTec	
SMC	CANAL-C Slag 10/28/1994			106	13.8	not reported		49	7.01	EcoTec	
	mean			425		103		224			
	median			322		86		209			
	standard deviation			414		92		184			
	number			39		36		33			
	$t_{0.025}$(95%CL)			1.96		1.96		1.96			
	UCL of the mean			555		133		287			

Notes:
All errors are 2 sigma (95% reporting errors)
(1) ORAU Table 6 samples are from the Fe-Cb High-Ratio Slag Pile as reported in Table 7 of ORAU 88/G-79, Radiological Survey of the Shieldalloy Corporation Newfield, New Jersey, J.D. Berger, and A.D. Luck, Final Report July 1988.
(2) ORAU Table 7 samples are from the Fe-Cb Standard Slag Pile as reported in Table 7 of ORAU 88/G-79, Radiological Survey of the Shieldalloy Corporation Newfield, New Jersey, J.D. Berger, and A.D. Luck, Final Report July 1988.
(3) Analysis results for the IEM and SMC were analyzed by isotopic Th, isotopic U, and gammma spec for Bi-214 and Pb-214 (used to quantify the Ra-226)

Table 8.1b - Baghouse Dust Uranium and Thorium ppm Results from Neutron Activation at the University of Missouri

Report	Sample Date	Location		Th ppm	Th error	U ppm	U error	Analysis Laboratory
IEM	7/31/1995	BHD	-001	144	34	17.1	0.3	Univ of MO
IEM	7/31/1995	BHD	-002	10	6	3.1	0.6	Univ of MO
IEM	7/31/1995	BHD	-003	397	10	63.5	3	Univ of MO
IEM	7/31/1995	BHD	-004	368	7	58.3	1.8	Univ of MO
IEM	7/31/1995	BHD	-005	38	10	15.1	3.7	Univ of MO
IEM	7/31/1995	BHD	-006	450	11	63.8	1.6	Univ of MO
IEM	7/31/1995	BHD	-007	427	22	59.6	2.5	Univ of MO
IEM	7/31/1995	BHD	-008	326	34	43.8	2	Univ of MO
IEM	7/31/1995	BHD	-009	341	6	46.3	2.9	Univ of MO
IEM	7/31/1995	BHD	-010	373	2	54	1.7	Univ of MO
IEM	7/31/1995	BHD	-011	202	26	58.6	8.8	Univ of MO
IEM	7/31/1995	BHD	-012	197	22	59.4	3.8	Univ of MO
IEM	7/31/1995	BHD	-013	200	9	26.8	0.1	Univ of MO
IEM	7/31/1995	BHD	-014	261	53	28	2.1	Univ of MO
IEM	7/31/1995	BHD	-015	182	11	29.6	1.5	Univ of MO

Table 8.1c Baghouse Dust Radionuclide Concentrations

Report	Collection Date	Location		Radionuclide concentration (pCi/g)						Analysis Lab	Notes
				Th-232	Th-232 error	Ra-226	Ra-226 error	U-238	U-238 error		
IEM	7/31/1995	BHD	-001	15.8	3.7			5.8	0.1	U of MO	1
IEM	7/31/1995	BHD	-002	1.1	0.7			1.0	0.2	U of MO	
IEM	7/31/1995	BHD	-003	43.5	1.1			21.4	1.0	U of MO	
IEM	7/31/1995	BHD	-004	40.4	0.8			19.6	0.6	U of MO	
IEM	7/31/1995	BHD	-005	4.2	1.1			5.1	1.2	U of MO	
IEM	7/31/1995	BHD	-006	49.4	1.2			21.5	0.5	U of MO	
IEM	7/31/1995	BHD	-007	46.8	2.4			20.1	0.8	U of MO	
IEM	7/31/1995	BHD	-008	35.8	3.7			14.7	0.7	U of MO	
IEM	7/31/1995	BHD	-009	37.4	0.7			15.6	1.0	U of MO	
IEM	7/31/1995	BHD	-010	40.9	0.2			18.2	0.6	U of MO	
IEM	7/31/1995	BHD	-011	22.2	2.9			19.7	3.0	U of MO	
IEM	7/31/1995	BHD	-012	21.6	2.4			20.0	1.3	U of MO	
IEM	7/31/1995	BHD	-013	21.9	1.0			9.0	0.0	U of MO	
IEM	7/31/1995	BHD	-014	28.6	5.8			9.4	0.7	U of MO	
IEM	7/31/1995	BHD	-015	20.0	1.2			10.0	0.5	U of MO	
ORAU	Table 16	Dust-Old Baghouse		76.5	3.2	27.5	1.6	20	11	ORAU	
ORAU	Table 16	Dust-Lime Pile 1 (East)		15.7	2.1	5.3	0.8	13.1	3.4	ORAU	
ORAU	Table 16	Dust-Lime Pile 2		43.8	2.4	15	1.2	10	7.2	ORAU	
ORAU	Table 16	Dust-Lime Pile 3		41.8	2.5	12.2	1.2	27	20	ORAU	
ORAU	Table 16	Dust-Lime Pile 4 (West)		71	3.2	19.1	1.6	13.5	6.2	ORAU	
ORISE	695M001	LP-1		47.9	4.9	22.8	1.7	9.4	1.5	ORISE/ESSAP	
ORISE	695M002	LP-2		80.4	8.4	25.5	2	25.3	5.7	ORISE/ESSAP	
ORISE	695M003	LP-3		15.4	1.7	5.5	0.5	6.1	1.7	ORISE/ESSAP	
ORISE	695M004	LP-4		128.7	13.4	36.3	2.9	34	6.5	ORISE/ESSAP	
mean				40		19		15			
median				39		19		15			
standard deviation				28		10		8			
n				24		9		24			
t .025 (95% CL)				2.069		2.306		2.069			
Mean at UCL				51		27		19			

Notes:
(1) Baghouse dust samples were analyzed by University of Missouri for parts per million (ppm) uranium and ppm thorium as reported in a September 11, 1995 letter from Carol D. Berger, IEM to C. Scott Eves, SMC, Re: Radiological Constituents in Samples Collected from the Lime Pile. The results were converted to activity

Report	Collection Date	Location	Radionuclide concentration (pCi/g)						Analysis Lab	Notes
			Th-232	Th-232 error	Ra-226	Ra-226 error	U-238	U-238 error		
concentration assuming that the uranium ppm was all U-238 and the thorium ppm was all Th-232										